The Paleocene of IODP Site U1511, Tasman Sea: A lagerstätte deposit for deep-water agglutinated foraminifera

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ABSTRACT: Deep-water agglutinated Foraminifera (DWAF) are investigated from Paleocene sediments recovered from IODP Hole U1511B in the northeastern Tasman Sea. The recovered foraminifera display exceptional three-dimensional preservation: they are relatively unaltered by sediment diagenesis and compaction. We examined 27 samples from Cores U1511B-45R to -47R, and recovered over 70 species of DWAF. The assemblage consists entirely of "cosmopolitan" forms originally described from the Carpathians, Caucasus, Trinidad, and the western Tethys, implying that there is no provinciality among DWAF faunas in the world ocean.

Keywords: Foraminifera, Paleocene, Tasman Sea, Lagerstätte

INTRODUCTION

Deep-water agglutinated foraminifera represent one of the most useful groups of microfossils for stratigraphical and paleoenvironmental interpretations of high-latitude Cretaceous to Miocene deep-water sedimentary sequences. They are often the only benthic microfossils preserved in the deep-water sediments deposited beneath the carbonate compensation depth (CCD). Their usefulness in biostratigraphic correlation in the western Tethyan and Boreal petroleum-producing basins has been emphasized in a series of studies since the early 1980s. The key studies carried out on the DWAF of the northern North Atlantic and western Tethys region have established the framework for the taxonomy and biostratigraphy of Paleogene DWAF (Gradstein and Berggren 1981; Miller et al. 1982; Verdenius and van Hinte 1983; Geroch and Nowak 1984; Kaminski et al. 1988; Kaminski et al. 1990; Kaminski and Geroch 1993; Gradstein et al. 1994, Olszewska 1997; Nagy et al. 1997, 2000, 2004; Kaminski and Austin 1999; Kaminski and Gradstein 2005; Kender et al., 2008a,b; Setoyama et al. 2011; 2017; Setoyama and Kaminski 2015; Waśkowska et al. 2020). However, little is known about the composition of Paleocene DWAF assemblages from the Pacific Ocean. The only published study of the DWAF in the Tasman Sea is the paper of Webb (1975), who examined samples from Deep Sea Drilling Project (DSDP) Leg 29, Site 283, which was only spot-cored. Webb documented 36 species in the Paleocene at Site 283, in spite of the fact that these were early days in the study of DWAF assemblages and the taxonomy was not yet well-established. Webb noted that at Site 283 "preservation is particularly good with only a small proportion of tests deformed".

In 2017, Integrated Ocean Discovery Program (IODP) Expedition 371 drilled another site (U1511) on the Tasman Abyssal Plain, west of Lord Howe Rise and on conjugate oceanic crust of Late Cretaceous age. The primary drilling objectives at this site were to constrain the age of deformation and to sample Paleogene strata to understand the evolution of this abyssal location. On-board analyses of benthic foraminifera revealed rich agglutinated assemblages, especially in the oldest, Paleocene and lower Eocene sediments (Sutherland et al. 2019). The purpose of this study is to document the taxonomic composition of the DWAF assemblages from the oldest recovered sediment at IODP Site U1511 drilled during IODP Expedition 371, which became known as the "Zealandia" Expedition.

Studied Site

IODP Site U1511 was drilled at a water depth of 4847 m during the Expedition 371 in the northeastern Tasman Sea (37.5611ºS, 160.3156ºE). It is located on the Tasman Abyssal Plain, on the conjugate margin opposite DSDP Site 283 (text-fig. 1). A total of 47 cores were drilled at Hole U1511B, with a total length of 431.4 m and an average core recovery of 65% (Sutherland et al. 2019). The hole did not reach basement. Paleogeographic and paleobathymetric reconstructions show that Site U1511 has been located at abyssal depths since the Paleocene, while bathyal and even shallower settings were located along Lord Howe Rise (Sutherland et al. 2020).

The most diverse benthic foraminiferal assemblages from Site U1511 are found in the lower Paleocene to lower Eocene claystone from cores U1511B-33R to U1511B-47R, where agglutinated foraminifera clearly dominate the assemblages (Sutherland et al. 2019). At present, this site is well below the regional lysocline (Bostock et al. 2011). However, the occurrence of a few specimens of calcareous benthic foraminifera and poorly preserved calcareous nannofossils toward the base of Hole U1511B (Cores -44R to -47R) indicates that Paleocene sediments accumulated above the CCD and below the lysocline (Sutherland et al. 2019).

Here we document the Paleocene DWAF assemblages from Cores U1511B-45R to U1511B-47R, which consist of moderately bioturbated greenish gray claystone. Calcareous nannofossils allowed identification of Zone NP4 (late Danian) in Core -45R, and planktonic foraminifera from Cores -44R to -47R indicate Subzones P1c-P4a, undifferentiated (Danian to Selandian), which correspond to the Teurian New Zealand stage (Sutherland et al. 2019).

METHODS

A total of 27 samples were disaggregated by boiling in sodium carbonate solution (Calgon), sieved over a 63 micron sieve, and dried in an oven. Foraminifera were picked from the >125 micron fraction and mounted onto cardboard microslides. Plesiotypes were photographed using a JEOL JCM-7000 Scanning Electron Microscope in the KFUPM Micropaleontology Lab. Microscope slides will be permanently housed in the European Micropalaeontological Reference Centre, Kraków, Poland.

RESULTS

Agglutinated foraminifera were recovered from all the studied samples in Cores U1511B-45R to -47R (Table 1), and they clearly dominate the benthic assemblages. The tubular genera comprise the largest proportion of the assemblage, and include *Nothia, Psammosiphonella, Rhizammina*, and *Hyperammina*. Other monothalamids include *Saccammina, Lagenammina, Placentammina,* and *Psammosphaera*. The ammodiscids are diverse, and include *Ammodiscus, Ammodiscoides, Dolgenia, Agathamminoides, Glomospira, Repmanina, Glomospirella*, and a distinctive hat-shaped species of *Arenoturrispirillina.* The pseudochambered forms include species of *Subreophax, Kalamopsis, Caudammina, Lituotuba, Paratrochamminoides,* and *Trochamminoides*. The rzehakinids occur consistently, and include species of *Rzehakina* and *Spirosigmoilinella* known from Trinidad and the Carpathians. The multichambered globothalamids comprise a comparatively small proportion of the assemblage, and consist mainly of the hormosinids such as *Arthrodendron, Reophax, Pseudonodosinella*, and lituolids such as *Bulbobaculites*, *Buzasina, Cribrostomoides, Haplophragmoides, Sphaerammina, Recurvoides, Recurvoidella, Spiroplectammina, Karrerulina,* and rare specimens of a primitive *Reticulophragmium*. Trochamminids are very rare.

Rare specimens of calcareous benthic taxa were found in three samples from Core 45R (45R-1W, 92-94 cm, 45R-2W, 0-2 cm, 45R-2W, 19-21 cm) and in the core-catcher sample. Among calcareous taxa, *Stensioeina beccariiformis* is abundant in the core catcher of Core 45R, and scarce *Nuttallides truempyi, Oridorsalis umbonatus*, and species of *Anomalinoides, Lagena, Lenticulina, Cibicidoides, Gyroidinoides*, and stilostomellid fragments were observed in the core catchers of the three studied cores (Sutherland et al. 2019).

Agglutinated foraminifera are undeformed by sediment compaction and unaltered by post-depositional silicification. A total of 73 DWAF species belonging to 44 genera were found in the current study.

SYSTEMATIC TAXONOMY

The classification of agglutinated foraminifera by Kaminski (2014) was used for the taxa listed below.

Class FORAMINIFEREA d'Orbigny 1826
Subclass MONOTHALAMANA Pawlowski, Holzmann and Tyszka 2013
Order ASTRORHIZIDA Lankester 1885
Suborder ASTRORHIZINA Lankester 1885
Family RHABDAMMINIDAE Brady 1884
Subfamily BATHYSIPHONINAE Avnimelech 1952
Genus *Nothia* Pflaumann 1964

Nothia excelsa (Grzybowski 1898)
Plate 1, figure 1

Dendrophrya excelsa GRZYBOWSKI 1898, p. 272, pl. 10, figs. 2–4.
Nothia excelsa (Grzybowski 1898). – GEROCH and KAMINSKI 1992, pl. 1, figs. 1–4, pl. 2, figs. 1–11. – KAMINSKI and GRADSTEIN 2005, p. 106, pl. 2, figs. 1–9. – BUBÍK 2019, pl. 1, fig. 1.

Remarks: Flattened, relatively coarsely agglutinated tubes.

Nothia latissima (Grzybowski 1898)
Plate 1, figure 2

Dendrophrya latissima GRZYBOWSKI 1898, p. 272, pl. 10, fig. 8.
Nothia latissima (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 111, pl. 3, figs. 1–4b. – KENDER, KAMINSKI and JONES 2008a, p. 118, pl. 1, fig. 17; pl. 2, fig. 1. – KENDER, KAMINSKI and JONES 2008b, p. 493, pl. 1, fig. 6. – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 30, pl. 1, figs. A–C.

Remarks: This species can be distinguished from other tubular taxa by its very wide, compressed test and very thin wall in proportion to the test size. The wall is comprised of fine quartz particles.

Genus *Psammosiphonella* Avnimelich 1952

Psammosiphonella cylindrica (Glaessner 1937)
Plate 1, figure 3

Rhabdammina cylindrica GLAESSNER 1937, p. 354, pl. 1, fig. 1.
Bathysiphon cylindrica (Glaessner). – WEBB 1975, p. 834, pl. 1, fig. 6.
Psammosiphonella cylindrica (Glaessner). – KAMINSKI and GRADSTEIN 2005, pl. 5/6, figs. 9–13 (with synonymy). – WAŚKOWSKA-OLIWA 2008, p. 250, pl. 1, fig. 1. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 280, pl. 2, fig. 6a, b. – SETOYAMA and KAMINSKI 2015, p. 242, pl. 1, fig. 5.

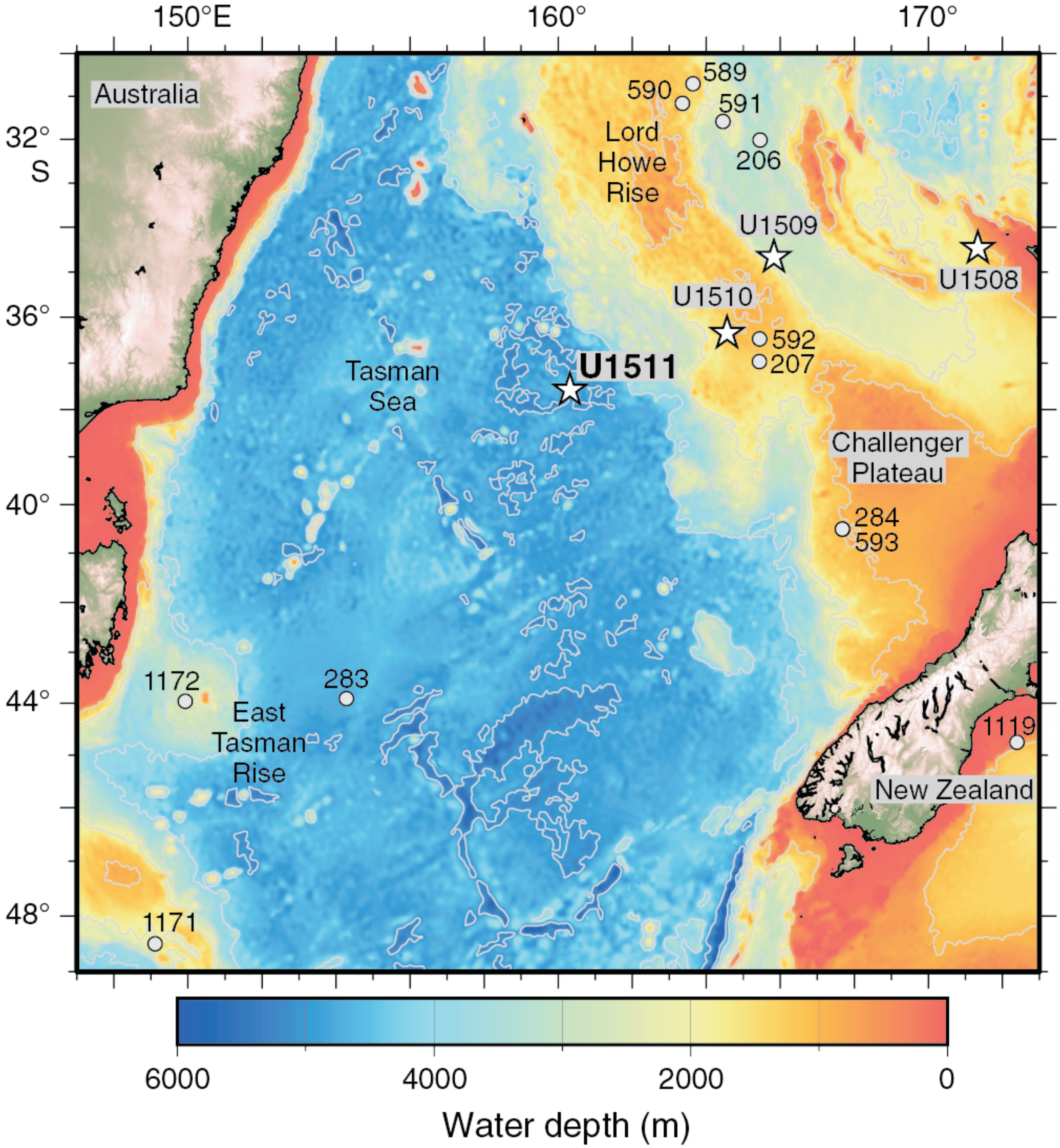
Psammosiphonella discreta (Brady 1881)
Plate 1, figure 4

Rhabdammina discreta BRADY 1881, p. 48.
Psammosiphonella discreta (Brady). – KAMINSKI and GRADSTEIN 2005, p. 117, pl. 5/6, figs. 1–8 (with synonymy). – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 280, pl. 1, fig. 6; pl. 2, fig. 7a, b. – SETOYAMA and KAMINSKI 2015, p. 242, pl. 1, fig. 6.

Family RHIZAMMINIDAE Wieser 1931
Genus *Rhizammina* Brady 1879

Rhizammina algaeformis Brady 1879
Plate 1, figure 5

Rhizammina algaeformis BRADY, 1879, p. 20, pl. 4, figs. 16–17. – KENDER and KAMINSKI 2017, p. 206, fig. 6:14 (with synonyms).
Rhizammina cf. *algaeformis* (Brady). – KUHNT, 1990, p. 324, pl. 1, fig. 1. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 83, pl. 1, figs. 2, 3.



TEXT-FIGURE 1
Location of DSDP/IODP sites in the Tasman Sea (modified after Sutherland et al. 2019). Expedition 371 sites are marked by stars.

Remarks: Flattened thin-walled tubes that have dimples on the outer surface of the wall, possibly derived from calcareous agglutinated grains that have been dissolved away.

***Rhizammina* sp. 1**
Plate 1, figures 6-7

Rhizammina algaeformis (Brady). – WEBB 1975, pl. 1, fig. 2.

Remarks: Thin-walled, curved and unbranched tubular specimens are included. The wall is comprised of fine quartz particles. Many specimens are also flattened due to their thin wall. This species differs from the modern species *R. algaeformis* in lacking calcareous particles in the agglutinated wall.

TABLE 1
Semiquantative abundances of agglutinated foraminifera in the samples from Hole U1511B.

Sample ID	*Agathamminoides serpens* (Grzybowski 1898)	*Ammodiscoides* sp. 1	*Ammodiscus* cf. *planus* Loeblich 1946	*Ammodiscus cretaceus* (Reuss 1845)	*Ammodiscus glabratus* Cushman and Jarvis 1928	*Ammodiscus tenuissimus* Grzybowski 1898	*Ammolagena clavata* (Jones and Parker 1860)	*Ammosphaeroidina pseudopauciloculata* (Mjatliuk 1966)	*Arenoturrispirillina micra* Subbotina 1958	*Arthrodendron grandis* (Grzybowski 1898)	*Bathysiphon nodosariaformis* Subbotina 1950	*Bulbobaculites* sp.	*Buzasina pacifica* (Krasheninnikov 1973)	*Caudammina ovula* (Grzybowski 1896) emend. Geroch 1960	*Caudammina ovuloides* (Grzybowski 1901)	*Conglophragmium irregularis* (White 1928)	*Conotrochammina whangaia* Finlay 1940	*Cribrostomoides subglobosus* (Cushman 1910)	*Cystammina sveni* Gradstein and Kaminski 1997	*Dolgenia pennyi* (Cushman and Jarvis 1928)	*"Glomospira" irregularis* (Grzybowski 1898)	*Glomospira* sp. 4 of Kaminski and Gradstein 2005	*Glomospirella* sp. 1	*Haplophragmoides* cf. *walteri* (Grzybowski 1898)	*Haplophragmoides decussatus* Krasheninnikov 1973	*Haplophragmoides porrectus* Maslakova 1955	*Haplophragmoides suborbicularis* (Grzybowski 1896)	*Hormosina velascoensis* (Cushman 1926)	*Hyperammina dilatata* Grzybowski 1896	*Hyperammina kenmilleri* Kaminski 1989	*Hyperammina erugata* Sliter 1968	*Hyperammina* sp. 1	*Jaculella* sp.	*Kalamopsis grzybowskii* (Dylążanka 1923)	*Karrerulina conversa* (Grzybowski 1901)	*Lagenammina* sp. 1	*Lituotuba lituiformis* (Brady 1879)
45R-1W, 22-24 cm			F			F		F			R			F					F	R					R	F				F				R	F		
45R-1W, 49-51 cm			F			F	R	F			F		F								F					F	F			F	R			R	F		
45R-1W, 92-94 cm			F			F	R	R	R	R	R			F						F	F			R			R			F	R				F		
45R-2W, 0-2 cm			F	R		R	R	F		R	R		R	R		R			R	F	F			R		R				F	R		R	R	F		
45R-2W, 19-21 cm	R		F			F		R			R	R	R	R						R	R		R	F						F					F		R
45R-2W, 40-42 cm			R	R		R						R		F	R				R											F					F		
46R-1W, 26-28 cm	R		C			F				R	C		R	F	R	R			F		R	R		R	R	F	R			F	R			R	F		
46R-1W, 47-49 cm		R	F		F	F		R		R	F		R	F						R	R					F	R			F				R	F		R
46R-1W, 90-92 cm			F	R	R	F					F	R	R	F					F	R	F			R		R	F	R	R	F	R			R	F		
46R-1W, 111-113 cm			F			F				R	R			R												R	R	R		C				R	F		
46R-1W, 141-143 cm			F	R	R	F	F	R											R							R	R			F				R	F		
46R-2W, 50-56 cm		R	F	R			R	R		F	R			R	R	R										F	R			F		R		F	F		
46R-2W, 75-77 cm			F			F	R	R		R										R	R		R	F	R	F				F	R	R			F	R	
46R-2W, 100-102 cm											R	R	R													R	R	R		F				R	F		
46R-2W, 122-124 cm		R	F	R		F	R			F	R		R	F		R			F	R	R			F	R	F					R			R	F		
46R-3W, 8-10 cm				R		C	R	R		R				R				R		R									R						F		
46R-3W, 45-47 cm			C	R		R	R				R		R	F				R	F	R	R				R	F		R	R	C				F	F		R
46R-3W, 80-82 cm				R		F					R			F					R					R	R	F								R	F		R
46R-3W, 120-122 cm						R		R		F	R			R	R			R			R	F						R				R		R	F		R
47R-1W, 30-32 cm	R		R			R	R											R	R					R	R			R			R	R			F		R
47R-1W, 71-73 cm								R										R				R		R													
47R-1W, 101-103 cm			F			R		F	R										F		R	R	R							F					F		
47R-2W, 109-111 cm	R		F	R				R	F	R							R		R	R				R		F				F					F		
47R-2W, 142-144 cm			R		R	R		F		R				R	R	R	R							R	R			R	R	F				R	F	R	R
47R-3W, 10-12 cm		R						F		R	R			R			R	R						R	R	R		R	R	F		R		R	R	R	
47R-3W, 52-54 cm	R	R	R	F	R	R	R	R		F	F			F		R		R		R	F		R	R	R	R		F	R	F	R				R	R	
47R-3W, 93-95 cm						R	R		R					R						R						F		R		F							

***Rhizammina* sp. 2**
Plate 1, figures 23-24

Remarks: Extremely fine and delicate narrow tubes that show occasional Y-shaped branching. The wall is comprised of fine quartz particles.

Suborder SACCAMMININA Lankester 1885
Superfamily SACCAMMINOIDEA Brady 1884
Family SACCAMMINIDAE Brady 1884
Subfamily SACCAMMININAE Brady 1884
Genus *Lagenammina* Rhumbler 1911

***Lagenammina* sp. 1**
Plate 1, figure 8

Lagenammina sp. KAMINSKI, SILYE and KENDER 2005, pl. 1, fig. 14.

Remarks: A small, coarsely agglutinated form with a chamber that tapers toward the aperture.

Genus *Placentammina* Thalmann 1947

Placentammina placenta (Grzybowski 1898)
Plate 1, figure 10

Reophax placenta GRZYBOWSKI 1898, p. 276, pl. 10, figs. 9–10.
Saccammina placenta (Grzybowski). – GEROCH 1960, p. 37, pl. 2, figs. 1–6. – JURKIEWICZ 1967, p. 41, pl. 1, fig. 5.
Placentammina placenta (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 136, pl. 11, figs. 1–6. – KENDER, KAMINSKI and JONES 2008a, p. 119, pl. 2, fig. 8. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 84, pl. 1, fig. 4. – ,WAŚKOWSKA GOLONKA, MACHOWSKI and PSTRUCHA 2018, pl. 6, figs. H–I.

Remarks: A thin-walled finely agglutinated form. Remarkably, some specimens in our samples are still partially inflated.

Genus *Saccammina* Carpenter 1869

Saccammina grzybowskii (Schubert 1902)
Plate 1, figure 11-12

Reophax grzybowskii SCHUBERT 1902, pl. 1, fig. 13.
Saccammina grzybowskii (Schubert 1902). – KAMINSKI and GRADSTEIN 2005, p. 132, pl. 10, figs. 1–7. – WAŚKOWSKA-OLIWA 2008, p. 251, pl. 2, figs. 2, 3, 5. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 84, pl. 1, fig. 5. – WAŚKOWSKA, GOLONKA, MACHOWSKI and PSTRUCHA 2018, pl. 6, figs. J–K. – WILSON et al. 2019, p. 13, pl. 1, fig. 3.

Remarks: A small, circular, finely agglutinated form with a thin wall and small, abruptly protruding aperture. Our specimens are somewhat smaller and more finely agglutinated than typical

TABLE 1
Continued.

Sample ID	*Nothia latissima* (Grzybowski 1898)	*Nothia excelsa* (Grzybowski 1898)	*Paratrochamminoides acervulatus* (Grzybowski 1896)	*Paratrochamminoides deflexiformis* (Noth 1912)	*Paratrochamminoides gorayskii* (Grzybowski 1898)	*Paratrochamminoides mitratus* (Grzybowski 1901)	*Paratrochamminoides olszewskii* (Grzybowski 1898)	*Paratrochamminoides uviformis* (Grzybowski 1898)	*Placentammina placenta* (Grzybowski 1898)	*Praesphaerammina gerochi* (Hanzlíková 1972)	*Psammosiphonella cylindrica* (Glaessner 1937)	*Psammosiphonella discreta* (Brady 1881)	*Psammosphaera* sp. 1.	*Pseudonodosinella elongata* (Grzybowski 1898)	*Recurvoidella lamella* (Grzybowski 1898)	*Recurvoides* spp.	*Reophax* sp. 1	*Repmanina charoides* (Jones and Parker 1860)	*Reticulophragmium pauperum* (Chapman 1904)	*Rhizammina algaeformis* Brady 1879	*Rhizammina* sp. 1	*Rhizammina* sp. 2	*Rzehakina epigona* (Rzehak 1895)	*Rzehakina fissistomata* Grzybowski 1898	*Rzehakina lata* Cushman and Jarvis 1928	*Rzehakina minima* Cushman and Renz 1946	*Saccammina grzybowskii* (Schubert 1902)	*Spiroplectammina spectabilis* (Grzybowski 1898), *megalospheric generation*	*Spiroplectammina spectabilis* (Grzybowski 1898), *microspheric generation*	*Spirosigmoilinella* sp.	*Subreophax aduncus* (Brady 1882)	*Subreophax longicameratus* Kaminski, Cetean, Balc and Coccioni 2011	*Subreophax pseudoscalaris* (Samuel 1977),	*Subreophax scalaris* (Grzybowski 1896)	*Trochammina* sp.	*Trochamminoides dubius* (Grzybowski)	*Trochamminoides grzybowskii* Kaminski and Geroch 1992
45R-1W, 22-24 cm		F		F					R					F		F		F			A	A				R	F	F	R	C	R			R	F		
45R-1W, 49-51 cm		R							R	R						F		F			A	A	R				F	F	R	C	C	R		R	R	R	
45R-1W, 92-94 cm					F		R							R		F		R	R		A	A	F				F	F	F	F	R	F			R		
45R-2W, 0-2 cm								R			R			F		F		R	R		A	A				R	R	F	F	F	R				R		
45R-2W, 19-21 cm	F			F		R	R		R	F	R	R		F		F		R	F		A	A	F				R	F	F	C		R	R	F	F		R
45R-2W, 40-42 cm		F		R			R	R			F					F		R			C	C	R					F	R	F	F		R	R	R		
46R-1W, 26-28 cm	F	C		F	R	R		R			F		R	F		F		R		R	A	A	R				R			C	C		F	F	F		
46R-1W, 47-49 cm		F	R	R	R				R	R	F	R		F		F				R	A	A	R				R			C	C		F	F	F	R	
46R-1W, 90-92 cm		F		R					R		F			F		F		R			A	A		F			R	F	F	C	F	R		R	F		
46R-1W, 111-113 cm		F		R			R			R	R		R	R		F		R			A	A		R			R	C	F	C	F	R			R		
46R-1W, 141-143 cm		C		F			R		R		C			R		F		R		R	A	A		R				C	F	C	F			R	F		R
46R-2W, 50-56 cm		C		F					R	R	C			F		F		F		R	A	A	R				R	C	F	C	F			R	F		
46R-2W, 75-77 cm		C		R				R	F	R	C		R	F		F					A	A	F					C	F	C	R		F	F	R		
46R-2W, 100-102 cm							R		R		C			R		R		R	R		A	A		F			R	C	F	C	R			R			
46R-2W, 122-124 cm	F		R				R		F		C			F							A	A					F	F	F	C	R	R	R	R	R		
46R-3W, 8-10 cm	R		R	R					R	R	F			F		F		C	R		A	A	R	F	R	F	R	C	R	F	R	R		R	F	R	
46R-3W, 45-47 cm			R	R	R	R	F	R		R	F			R		F		F		F	A	A		R	F		F	C	R	C	F			F	F		
46R-3W, 80-82 cm				R			F	R		R				F							A	A	R	R			R	C	F	F	R	R	R	R	R		
46R-3W, 120-122 cm	R				R					F	F		R	R	R	R			R		C	C				R	F	F			R			F	F		
47R-1W, 30-32 cm			R	R		R					F			R				R			C	C					R	R		F	R		F	F			
47R-1W, 71-73 cm													R							R	C	C						F		F	R				R		
47R-1W, 101-103 cm				R		R					F		R		R	F		R	F		A	A	R				R	F	R	F	R		R	R	R		R
47R-2W, 109-111 cm			R				R				F	F	R	R		F		R			A	C	R	R		F	R	F	F	F	F			R	R		R
47R-2W, 142-144 cm							R								R	F					A	C	R	R		R	R	F	R	F	R			R	R		R
47R-3W, 10-12 cm										R	R				R	F					A	A		R	R	R	R	F	F	R				R	R		R
47R-3W, 52-54 cm	R		R				R		R		F	F		R		F	R	R	R	R	A	A	R			R	F	F	R	F	R	R	R	R	F		R
47R-3W, 93-95 cm						R										R	R	F		R	A	A		R		C	R	C	R	R	R		R	R	R	R	

Saccammina grzybowskii (Schubert), but we consider them conspecific.

Superfamily PSAMMOSPHAEROIDEA Haeckel 1894
Family PSAMMOSPHAERIDAE Haeckel 1894
Subfamily PSAMMOSPHAERINAE Haeckel 1894
Genus *Psammosphaera* Schulze 1875

***Psammosphaera* sp. 1.**
Plate 1, figure 13

Remarks: A medium-sized form with a small aperture. Test wall made of spicules.

Subclass TUBOTHALAMANA Pawlowski, Holzmann and Tyszka 2013
Order AMMODISCIDA Mikhalevich 1980
Suborder HIPPOCREPININA Saidova 1981
Superfamily HIPPOCREPINOIDEA Rhumbler 1895
Family HIPPOCREPINIDAE Rhumbler 1895
Subfamily JACULELLINAE Mikhalevich 1995
Genus *Jaculella* Brady 1879

***Jaculella* sp.**
Plate 1, fig. 14

Test elongate and tapered. Differs from the type species Jaculella acuta Brady in its much smaller dimensions and in having a thin, finely agglutinated wall. Rare specimens were found in Core -45R.

Family HYPERAMMINIDAE Eimer and Fickert 1899
Subfamily HYPERAMMININAE Eimer and Fickert 1899
Genus *Hyperammina* Brady 1878

Hyperammina dilatata Grzybowski 1896
Plate 1, figures 15-16

Hyperammina dilatata GRZYBOWSKI 1896, p. 274, pl. 8, fig. 17a,b. – LISZKA and LISZKOWA 1981, p. 162, pl. 1, fig. 8. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 191, pl. 1, fig. 8.
"Hyperammina dilatata" Grzybowski. – KAMINSKI and GRADSTEIN 2005, p. 140, pl. 12, figs. 1–5 (with synonymy).

Remarks: The test tapers toward the aperture.

Hyperammina kenmilleri Kaminski 1989
Plate 1, figures 17-19

Hyperammina kenmilleri KAMINSKI in KAMINSKI, GRADSTEIN and BERGGREN 1989, p. 732, pl. 2, figs. 2–3. – WAŚKOWSKA 2011, Fig. 5, 8–10. – KAMINSKI and ORTIZ 2014, pl. 1, fig. 3.

Remarks: The species was first described from the abyssal Labrador Sea. It is a small finely-agglutinated species with an oval proloculus.

Hyperammina erugata Sliter 1968
Plate 1, figures 20-21

Hyperammina erugata SLITER 1968, p. 41, pl. 1, fig. 6.

Remarks: Significantly larger than *H. kenmilleri,* with a thick, finely agglutinated wall. First described from the Upper Cretaceous of southern California.

***Hyperammina* sp. 1**
Plate 1, figure 22

Remarks: A small, irregular form with a relatively coarse wall. Tubular second chamber is narrow and often bent.

Superfamily HORMOSINELLOIDEA Rauser and Reitlinger 1986
Family AMMOLAGENIDAE Kaminski, Henderson, Cetean and Waśkowska 2009
Genus *Ammolagena* Eimer and Fickert 1899, emend. Kaminski et al. 2009

Ammolagena clavata (Jones and Parker 1860)
Plate 2, figures 1-2

Trochammina irregularis (d'Orbigny) var. *clavata* JONES and PARKER 1860, p. 304.
Ammolagena clavata (Jones and Parker). – WEBB 1975, p. 834, pl. 1, fig. 16. – KAMINSKI and GRADSTEIN 2005, p. 165, pl. 21, figs. 1–6. KAMINSKI, HENDERSON, CETEAN and WAŚKOWSKA 2009, p. 488, text-fig. 1, pl. 1, figs. 1-6; pl. 2, figs. 1-12. – WAŚKOWSKA 2014, pl. 1, figs. 1–16, pl. 2, figs. 1–13.

Remarks: The test is commonly attached to shell fragments or to other foraminifers, up to 2 mm in length, large ovoid proloculus followed by narrower tubular rectilinear chamber, rarely linked to form a pseudo-multichambered chain (Kaminski et al. 2009). The wall is finely agglutinated. Kaminski and Gradstein (2005) designated a lectotype for the type species from the Jones and Parker collection in the NHM, London.

Family HORMOSINELLIDAE Rauser and Reitlinger 1986
Genus *Caudammina* Montanaro-Gallitelli 1955

Caudammina ovula (Grzybowski 1896) emend. Geroch 1960
Plate 2, figure 3

Reophax ovulum GRZYBOWSKI 1896, p. 276, pl. 8, figs. 19–21.
Hormosina ovulum (Grzybowski). – WEBB 1975, p. 834, pl. 2, figs. 1-2.
Hormosina ovulum ovulum (Grzybowski). – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 186, pl. 2, fig. 10.
Caudammina ovula (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 233, pl. 41, figs. 1–8 (with synonymy). – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 86, pl. 2, fig. 3. HOLBOURN, HENDERSON and MACLEOD 2013, p. 146, figs. 1, 2. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 270, pl. 4, figs. 5–7. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 1, figs. 12, 13.

Remarks: Characterized by its spherical test shape and small apertures.

Caudammina ovuloides (Grzybowski 1901)
Plate 2, figures 4-5

Reophax ovuloides GRZYBOWSKI 1901, p. 233, pl. 8, fig. 3.
Hormosina ovuloides (Grzybowski). – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 186, pl. 2, figs. 3, 4.
Caudammina ovuloides (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 238, pl. 42, figs. 1–7 (with synonymy). – WAŚKOWSKA-OLIWA 2008, p. 248, pl. 6– 8. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 270, pl. 4, fig. 8. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 1, figs. 14, 15.

Remarks: The specimens in this study do not possess a long stolon, and the chambers overlap with different degrees. The size of chambers does not change much as added.

Genus *Subreophax* Saidova 1975

Subreophax aduncus (Brady 1882)
Plate 2, figure 6

Reophax aduncus BRADY 1882, p. 715 (type figure not given).
Subreophax aduncus (Brady). – CHARNOCK and JONES 1990, p. 165, pl. 4, fig. 20; pl. 15, fig. 18. – KAMINSKI and CETEAN 2011 p. 64, pl. 2, figs. 4–6 (Lectotype). – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 87, pl. 2, figs. 14–16. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 1, fig. 16.

Remarks: A small species with pseudochambers that increase in size very slowly or not at all.

Subreophax longicameratus Kaminski, Cetean, Bălc and Coccioni 2011
Plate 2, figure 7

Subreophax longicameratus KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 87, pl. 2, figs. 17–21, pl. 3, figs. 1–5. – SETOYAMA and KAMINSKI 2015, pl. 1, fig. 17.

Remarks: It differs from other species of *Subreophax* (*S. aduncus, S. scalaris*, *S. pseudoscalaris*) by the elongated shape of the pseudochambers and by the larger size of the test. Originally described from the Maastrichtian of the Contessa Highway section in Italy. Setoyama and Kaminski (2015) reported it from the Santonian–Campanian Nise Formation of the Norwegian Sea.

Subreophax scalaris (Grzybowski 1896)
Plate 2, figure 8

Reophax guttifera (Brady) var. *scalaria* GRZYBOWSKI, 1896, p. 277, pl. 8, fig. 26a, b.
Subreophax sp. 1. KAMINSKI, SILYE and KENDER 2005, p. 392, pl. 3, fig. 1.
Subreophax scalaris (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 278, pl. 55, figs. 1–7. – KENDER, KAMINSKI and JONES 2008a, p. 122, pl. 4, figs. 12, 13. – KENDER, KAMINSKI and JONES 2008b, p. 497, pl. 3, figs. 3, 4. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 87, pl. 3, fig. 7. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 286, pl. 4, fig. 15. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 1, fig. 18. – WAŚKOWSKA 2015b, pl. 10, figs. s, t. – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA, 2020, p. 65, pl. 20, figs. A–D.

Remarks: Differs from *S. aduncus* in possessing a coarser wall and pseudochambers that increase in size.

Subreophax pseudoscalaris (Samuel 1977)
Plate 2, figures 9-10

Reophax pseudoscalaria SAMUEL 1977, p. 36, pl. 3, fig. 4a, b.
Subreophax pseudoscalaris (Samuel). – KAMINSKI and GRADSTEIN 2005, p. 281, pl. 56, figs. 1–6. – KENDER, KAMINSKI and JONES 2008a, p. 122, pl. 4, fig. 11. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 87, pl. 3, fig. 6. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 196, pl. 1, fig. 17. – WAŚKOWSKA, GOLONKA, MACHOWSKI and PSTRUCHA 2018, pl. 7, fig. D.

Remarks: A robust form with a thick wall.

Suborder AMMODISCINA Mikhalevich 1980
Superfamily AMMODISCOIDEA Reuss 1862
Family AMMODISCIDAE Reuss 1862
Subfamily AMMODISCINAE Reuss 1962
Genus *Agathamminoides* Vangerow 1964

Agathamminoides serpens (Grzybowski 1898)
Plate 2, figure 11

Ammodiscus serpens GRZYBOWSKI 1898, p. 285, pl. 10, fig. 31.
Glomospira serpens (Grzybowski). – WEBB 1975, p. 834, pl. 1, fig. 15. – KAMINSKI and GRADSTEIN 2005, p. 189, pl. 27, figs. 1–6. – WAŚKOWSKA 2015a, pl. 11, figs. r–s.
Agathamminoides serpens (Grzybowski). – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 45, pl. 9, figs. A, B.

Remarks: Now placed in the genus *Agathamminoides* Vangerow 1964 because of its triloculine coiling.

Genus *Ammodiscoides* Cushman 1909

***Ammodiscoides* sp. 1**
Plate 2, figure 12

Remarks: A large form with three whorls in the trochospiral part and three in the planispiral part. Wall thick and coarsely agglutinated as in the genus *Dolgenia*.

Genus *Ammodiscus* Reuss 1962

Ammodiscus cretaceus (Reuss 1845)
Plate 2, figure 13

Operculina cretacea REUSS 1845, p. 35, pl. 13, figs. 64, 65.
Ammodiscus cretaceus (Reuss). – CUSHMAN 1934, p. 45. – WEBB 1975, p. 834, pl. 1, fig. 9. – KUHNT 1990, p. 310, pl. a, figs. 2, 3 – KAMINSKI and GRADSTEIN 2005, p. 145, pl. 14, figs. 1a–10 (with synonymy). – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 266, pl. 3, fig. 5. – WAŚKOWSKA-OLIWA 2008, p. 247, pl. 2, fig. 6. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 2, fig. 1.

Remarks: Differs from *Ammodiscus glabratus* Cushman and Jarvis 1928 by its larger, more evolute, less biconcave test. Some specimens show clear striations.

Ammodiscus glabratus Cushman and Jarvis 1928
Plate 2, figure 14

Ammodiscus glabratus CUSHMAN and JARVIS 1928, p. 87, pl. 12, fig. 6a, b. – KAMINSKI and GRADSTEIN 2005, p. 148, pl. 15, figs. 1a–6. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 266, pl. 2, fig. 11a, b.

Remarks: Biconcave oval planispiral specimens with convolute coiling (whorls overlap to a greater degree than in *A. cretaceus*).

Ammodiscus* cf. *planus Loeblich 1946
Plate 2, figure 16

cf. *Ammodiscus planus* LOEBLICH 1946, p. 133, pl. 22, fig. 2.
Ammodiscus planus Loeblich 1946. – KAMINSKI, GRADSTEIN, GEROCH and BECKMANN 1988, p. 185, pl. 3, fig. 13.

Remarks: A small, very thin-walled, compressed, finely agglutinated form with several whorls.

Ammodiscus tenuissimus Grzybowski 1898
Plate 2, figure 15

Ammodiscus tenuissimus GRZYBOWSKI 1898, p. 282, pl. 10, fig. 35. – KAMINSKI and GEROCH, 1993, p. 253, pl. 5, figs. 1–3b. – KAMINSKI and GRADSTEIN, 2005, p. 163, pl. 20, figs. 1a–7. – WAŚKOWSKA-OLIWA 2008, p. 247, pl. 2, figs. 9–10.

Remarks: Thinner with more whorls compared with *A. cretaceus.*

Genus *Dolgenia* Kemper 1995

Dolgenia pennyi (Cushman and Jarvis 1928)
Plate 2, figure 17

Ammodiscus pennyi CUSHMAN and JARVIS 1928, p. 87, pl. 12, figs. 4-5. – WEBB 1975, p. 834, pl. 1, fig. 8. – KAMINSKI and GRADSTEIN 2005, p. 155, pl. 17, figs. 1–6. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 36, fig. 1.
Dolgenia pennyi (Cushman and Jarvis 1928). – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 85, pl. 1, fig. 13. – CETEAN, BĂLC KAMINSKI and FILIPESCU 2011, pl. 1, fig. 5.

Remarks: The species was transferred to the genus *Dolgenia* Kemper, 1995 based on its coarsely agglutinated wall and occasional irregular coiling in the final whorls

Genus *Arenoturrispirillina* Tairov 1956

Arenoturrispirillina micra Subbotina 1958
Plate 3, figure 1

Arenoturrispirillina micra SUBBOTINA 1958, p. 10, pl. 1, fig. 10. – WEBB 1975, p. 834, pl. 1, figs. 10, 11.

Remarks: A conical form first described from the upper Eocene of the southern Caucasus (Subbotina in Bykova 1958).

Subfamily AMMOVERTELLININAE Saidova 1981
Genus *Glomospirella* Plummer 1945

***Glomospirella* sp. 1**
Plate 3, figure 2

Remarks: Central area consisting of about 4 whorls, coiled glomospirally, followed by 3 to 4 planispiral whorls. Central area is thicker than the planispiral portion.

Subfamily USBEKISTANIINAE Vialov 1968
Genus *Glomospira* Rzehak 1885

"*Glomospira*" *irregularis* (Grzybowski 1898)
Plate 3, figure 3

Ammodiscus irregularis GRZYBOWSKI 1898, p. 285, pl. 11, figs. 2, 3.
Glomospira? irregularis (Grzybowski). – HEMLEBEN and TROESTER 1984, p. 519, pl. 1, fig. 22.
Glomospira (*Tolypammina*?) *irregularis* (Grzybowski). – KUHNT 1990, p. 311, pl. 1, fig. 12.
Glomospira irregularis (Grzybowski). – KAMINSKI and GEROCH 1993, p. 256, pl. 6, figs. 6–8b. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 272, pl. 3, fig. 20; pl. 7, fig. 1.
"Glomospira" irregularis (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 185, pl. 26, figs. 1a–7 (with synonymy). – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 85, pl. 1, fig. 15. – SETOYAMA and KAMINSKI 2015, p. 243, pl. 2, figs. 6, 7.

Remarks: Distinguished from other species of *Glomospira* by its large size, irregular coiling, and rough test surface.

***Glomospira* sp. 4**
Plate 3, figures 4-5

Glomospira sp. 4 KAMINSKI and GRADSTEIN 2005, p.198, pl. 30, figs. 1–9.

Remarks: Test large, relatively coarsely agglutinated, glomospirally coiled as in *G. gordialis* (Jones and Parker), but with a depressed coil suture between the whorls, becoming irregular. First described (informally) from the Eocene of the Labrador Sea. It also occurs in the Eocene of the North Sea and Morocco.

Genus *Repmanina* Suleymanov, in Arapova and Suleymanov 1966

Repmanina charoides (Jones and Parker 1860)
Plate 3, figure 6

Trochammina squamata var. *charoides* JONES and PARKER 1860, p. 304 (type figure not given).
Glomospira charoides (Jones and Parker). – BERGGEN and KAMINSKI 1990, p. 60, pl. 1, fig. 2 (lectotype). – KUHNT 1990, p. 311, pl. 1, figs. 9, 10. – KAMINSKI and GRADSTEIN 2005, p. 168, pl. 22, figs. 1–16 (with synonymy). – HOLBOURN, HENDERSON and MACLEOD 2013, p. 268, fig. 1.
Repmanina charoides (Jones and Parker). – ALEGRET and THOMAS 2001, p. 201, pl. 10, fig. 11. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 86, pl. 1, fig. 17a, b. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 283, pl. 3, figs. 22, 23.

Superfamily LITUOTUBOIDEA Loeblich and Tappan 1984
Family LITUOTUBIDAE Loeblich and Tappan 1984
Genus *Lituotuba* Rhumbler 1895

Lituotuba lituiformis (Brady 1879)
Plate 2, figure 7

Trochammina lituiformis BRADY 1879, p. 59, pl. 5, fig. 16.
Lituotuba lituiformis (Brady). – KUHNT 1990, p. 318, pl. 1, figs. 17, 18. – KAMINSKI and GRADSTEIN 2005, p. 287, pl. 58, figs. 1–8. – KENDER, KAMINSKI and JONES 2008a, p. 123, pl. 5, fig. 17; pl. 6, fig. 1. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 88, pl. 3, fig. 12. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 340, fig. 1. – SETOYAMA and KAMINSKI 2015, p. 245, pl. 2, fig. 8.

Remarks: Only one specimen was recorded in this study. This species can be readily distinguished from species of *Paratrochamminoides* and *Trochamminoides* by its rudimentary chambers and uncoiled portion.

Genus *Paratrochamminoides* Soliman 1972

Paratrochamminoides acervulatus (Grzybowski 1896)
Plate 3, figures 8-9

Trochammina acervulatus Grzybowski 1896, p. 274, pl. 9, fig. 4
Paratrochamminoides acervulatus (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 290, pl. 59, figs. 1–7. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 88, pl. 3, fig. 16. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 192, pl. 1, fig. 23.

Remarks: Recognized by its trochospiral coiling.

Paratrochamminoides deflexiformis (Noth 1912), emend. Kaminski and Gradstein (2005)
Plate 3, figures 10-11

Trochammina deflexiformis NOTH 1912, p. 14, pl. 1, fig. 10.
Paratrochamminoides deflexiformis (Noth). – KAMINSKI and GRADSTEIN 2005, p. 293, pl. 60, figs. 1a–4b. – KENDER, KAMINSKI and JONES 2008b, p. 499, pl. 3, fig. 17. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 88, pl. 3, fig. 17.

Remarks: Recognized by its glomospiral coiling.

Paratrochamminoides gorayskii (Grzybowski 1898), emend. Kaminski and Geroch 1993
Plate 2, figure 12

Ammodiscus gorayskii GRZYBOWSKI 1898, p. 283, pl. 11, fig. 5.
Paratrochamminoides gorayskii (Grzybowski). – KAMINSKI and GEROCH 1993, p. 255, pl. 5, fig. 8a–d. – KAMINSKI and GRADSTEIN 2005, p. 297, pl. 61, figs. 1a–5. – KENDER, KAMINSKI and JONES 2008a, p. 123, pl. 6, fig. 9. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 278, pl. 5, figs. 9, 10. KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 89, pl. 4, figs. 1, 2. – SETOYAMA and KAMINSKI 2015, p. 245, pl. 2, fig. 9.

Remarks: Recognized by its triloculine coiling.

Paratrochamminoides mitratus (Grzybowski 1901)
Plate 3, figure 13

Trochammina mitrata GRZYBOWSKI 1901, p. 280, pl. 8, fig. 3.
Trochamminoides irregularis (White). – WEBB 1975, p. 835, pl. 2, fig. 13.
Paratrochamminoides mitratus (Grzybowski). – KAMINSKI and GEROCH 1993, p. 278, pl. 16, fig. 4a,b. – KAMINSKI and KUHNT 2004, p. 282 (no figure given). – KAMINSKI and GRADSTEIN, 2005, p. 302, pl. 63, figs. 1a–7. – KENDER, KAMINSKI and JONES 2008b, p. 499, pl. 4, fig. 2.

Remarks: Recognized by its streptospiral coiling.

Paratrochamminoides olszewskii (Grzybowski 1898)
Plate 3, figure 14a,b

Trochammina olszewskii GRZYBOWSKI 1898, p. 298, pl. 11, fig. 6.
Paratrochamminoides olszewskii (Grzybowski). – KAMINSKI and GEROCH 1993, p. 257, pl. 7, figs. 1, 2. – KAMINSKI and KUHNT 2004, p. 282 (no figure given). – KAMINSKI and GRADSTEIN 2005, p. 305, pl. 64, figs. 1a–7. – KENDER, KAMINSKI and JONES 2008a, p. 123, pl. 6, figs. 10, 11. – KENDER, KAMINSKI and JONES 2008b, p. 499, pl. 4, fig. 3.

Remarks: Recognized by its glomospiral coiling and elongated chambers.

Paratrochamminoides uviformis (Grzybowski 1901)
Plate 3, figure 15

Trochammina uviformis GRZYBOWSKI 1901, p. 281, pl. 8, figs. 1, 2.
Paratrochamminoides uviformis (Grzybowski 1901). – KAMINSKI and GEROCH, 1993, p. 278, pl. 16, fig. 7. – SETOYAMA, KAMINSKI and TYSZKA, 2011, p. 279, pl. 5, fig. 12. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 89, pl. 4, fig. 5.

Remarks: Recognized by its high trochospiral coiling and bead-like pseudochambers.

Genus *Conglophragmium* Bermúdez and Rivero 1963, emend. Kaminski and Kuhnt 2004

Conglophragmium irregularis (White 1928)
Plate 3, figure 16

Trochamminoides irregularis WHITE 1928, p. 307, pl. 42, fig. 1.
Conglophragmium irregularis (White). – KAMINSKI and GRADSTEIN 2005, p. 284, pl. 57, figs. 1–6. – KENDER, KAMINSKI and JONES 2008a, p. 124, pl. 7, fig. 2.

Remarks: Recognized by its streptospiral involute coiling and large chambers.

Family TROCHAMMINOIDAE Haynes and Nwabufo-Ene 1998
Genus *Trochamminoides* Cushman 1910

Trochamminoides dubius (Grzybowski)
Plate 3, figure 18

Ammodiscus dubius GRZYBOWSKI 1901, p. 274, pl. 8, figs. 12, 14.
Trochamminoides dubius (Grzybowski). – KAMINSKI and GEROCH 1993, p. 275, pl. 15, fig. 9. – KAMINSKI and GRADSTEIN 2005, p. 308, pl. 65, figs. 1–8. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 89, pl. 3, figs. 13-14.

Trochamminoides proteus (Karrer 1866) emend. Rögl 1995
Trochammina proteus KARRER 1866, p. 494, pl. 1, fig. 8 (not figs. 1–7).
Trochamminoides proteus (Karrer). – RÖGL 1995, p. 255, text-figs. 7–9; pl. 2, figs. 1–6. – KAMINSKI and GRADSTEIN 2005, p. 314, pl. 67, figs. 1–5.

Trochamminoides grzybowskii Kaminski and Geroch 1992
Plate 3, figure 17a,b

Trochammina elegans GRZYBOWSKI 1898, p. 287, pl. 11, fig. 10.
Trochamminoides proteus (Karrer). – WEBB 1975, p. 835, pl. 2, fig. 14.
Trochamminoides grzybowskii KAMINSKI and GEROCH 1992, p. 137, fig. 1. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 89, pl. 3, fig. 15; pl. 4, fig. 7. HOLBOURN, HENDERSON and MACLEOD 2013, p. 576, fig. 1. – WAŚKOWSKA, GOLONKA, MACHOWSKI and PSTRUCHA 2018, pl. 7, figs. E–F.

Remarks: Recognized by its evolute coiling and large number of pseudochambers in the final whorl.

Order SCHLUMBERGERINIDA Mikhalevich 1980
Suborder SCHLUMBERGERININA Mikhalevich 1980
Superfamily RZEHAKINOIDEA Cushman 1933
Family RZEHAKINIDAE Cushman 1933
Subfamily RZEHAKININAE Cushman 1933
Genus *Rzehakina* Cushman 1927

Rzehakina epigona (Rzehak 1895)
Plate 4, figure 1

Silicina epigona RZEHAK 1895, p. 214, pl. 6, fig. 1a–c.
Rzehakina epigona (Rzehak). – WEBB 1975, p. 834, pl. 2, fig. 4. – BUBÍK and KAMINSKI 2000, p. 75, pl. 1, figs. 1a–4b. – KAMINSKI and GRADSTEIN 2005, p. 205, pl. 31, figs. 1a–4b (with synonymy). – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 284, pl. 3, figs. 25, 26; pl. 7, fig. 3a, b. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 496, fig. 1. – SETOYAMA and KAMINSKI 2015, p. 245, pl. 2, fig. 10

Remarks: As noted by Bubík and Kaminski (2000), this species is morphologically variable.

Rzehakina fissistomata (Grzybowski 1901)
Plate 4, figure 2

Spiroloculina fissistomata GRZYBOWSKI 1901, p. 45, pl. 7, figs. 22–24.
Rzehakina fissistomata (Grzybowski). – KAMINSKI and GRADSTEIN, 2005, p. 206, pl. 32, figs. 1–8.

Remarks: Thinner and more evolute than *Rz. epigona*.

Rzehakina lata Cushman and Jarvis 1928
Plate 4, figure 3

Rzehakina epigona var. *lata* CUSHMAN and JARVIS, 1928, p. 93, pl. 13, fig. 11a, b.
Rzehakina lata Cushman and Jarvis. – KAMINSKI and GRADSTEIN, 2005, p. 212, pl. 34, figs. 1–5. – WAŚKOWSKA, JONIEC, KOTLARCZYK and SIWEK 2019, pl. 11, figs. a, b.

Remarks: Differs from *Rz. epigona* in being thicker and in possessing more embracing final chambers.

Rzehakina minima Cushman and Renz 1946
Plate 4, figures 4

Rzehakina epigona (Rzehak) var. *minima* CUSHMAN and RENZ 1946, p. 24, pl. 3, fig. 5.
Rzehakina epigona Cushman and Renz. – KAMINSKI and GRADSTEIN 2005, p. 215, pl. 35, figs. 1a–10 (with synonymy). – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 284, pl. 4, fig. 1; pl. 7, fig. 5a, b. – WAŚKOWSKA 2011, fig. 5. 26, 27. – SETOYAMA and KAMINSKI 2015, p. 245, pl. 2, fig. 11.

Remarks: This species can be distinguished from the other species of *Rzehakina* by its slender test with evolute coiling mode and chambers that increase in thickness slowly as added.

***Spirosigmoilinella* sp.**
Plate 4, figure 5

Remarks: Test elongated, narrower than *Rzehakina*, with initial whorls in various planes. Setoyama et al. (2011, p. 285) described a similar species as *Spirosigmoilinella* sp. 1 from the Upper Cretaceous of the Western Barents Sea.

Subclass GLOBOTHALAMANA Pawlowski, Holzmann and Tyszka 2013
Order LITUOLIDA Lankester 1885
Suborder HORMOSININA Mikhalevich 1980
Superfamily HORMOSINOIDEA Haeckel 1894
Family ASCHEMOCELLIDAE Vialov 1966
Genus *Arthrodendron* Ulrich 1904

Arthrodendron grandis (Grzybowski 1898)
Plate 1, figure 9

Reophax grandis GRZYBOWSKI 1898, p. 277, pl. 10, figs. 13-15.
Aschemocella grandis (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 227, pl. 39, figs. 1–8. – KENDER, KAMINSKI and JONES 2008b, p. 497, pl. 3, fig. 5.
Arthrodendron grandis (Grzybowski). – WAŚKOWSKA, JONIEC, KOTLARCZYK and SIWEK 2019, pl. 11, fig. n. – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 67, pl. 21, figs. A–C.

Remarks: Large round chambers or fragments thereof, with a thin wall.

Genus *Kalamopsis* de Folin 1883

Kalamopsis grzybowskii (Dylążanka 1923)
Plate 4, figure 6

Hyperammina grzybowskii DYLĄŻANKA 1923, p. 65.
Kalamopsis grzybowskii (Dylążanka). – WEBB 1975, p. 834, pl. 1, figs. 18, 19. –KAMINSKI and GRADSTEIN 2005, p. 252, pl. 47, figs. 1–12 (with synonymy). – WAŚKOWSKA-OLIWA 2008, p. 249-250, pl. 4, figs. 3–5. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 277, pl. 4, figs. 18, 19. HOLBOURN, HENDERSON and MACLEOD 2013, p. 316, figs. 1, 2. – SETOYAMA and KAMINSKI 2015, p. 245, pl. 2, fig. 12.
Bathysiphon nodosariaformis SUBBOTINA 1950, p. 67, pl. 4, figs. 1–7. – BULATOVA in SUBBOTINA 1964, p. 87, pl. 3, figs. 1–8 (non figs. 9–11). – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 269, pl. 1, fig. 4. – SETOYAMA and KAMINSKI 2015, p. 241, pl. 1, fig. 2. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 187, pl. 1, fig. 2.

Remarks: Specimens display constrictions at the broken end of the tubular chamber.

Family REOPHACIDAE Cushman 1927
Genus *Reophax* de Montfort 1808

***Reophax* sp. 1**
Plate 4, figure 7

Remarks: Test small, flattened, with a coarse wall. The final chamber is pyriform, aperture on a produced neck.

Family HORMOSINIDAE Haeckel 1894
Subfamily HORMOSININAE Haeckel 1894
Genus *Hormosina* Brady 1879

Hormosina velascoensis (Cushman 1926)
Plate 4, figures 8, 9

Nodosinella velascoensis CUSHMAN 1926, p. 586, pl. 20, fig. 9.
Hormosina velascoensis (Cushman). – KAMINSKI and GRADSTEIN 2005, p. 243, pl. 44, figs. 1–8. – WAŚKOWSKA-OLIWA 2008, p. 249, pl. 6, figs. 9–11. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 276, pl. pl. 5, fig. 1. – CETEAN, BĂLC, KAMINSKI and FILIPESCU 2011, pl. 1, fig. 14.

Genus *Pseudonodosinella* Saidova 1970

Pseudonodosinella elongata (Grzybowski 1898)
Plate 4, figure 10

Reophax elongatus GRZYBOWSKI 1898, p. 279, pl. 33, figs. 19-20.
Pseudonodosinella elongata (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 256, pl. 48, figs. 1-9. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 432, fig. 1. – WAŚKOWSKA 2015a, p. 10, figs. p–r. – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 73, pl. 23, fig. C.

Remarks: Chambers are more elongated compared with *Hormosina velascoensis*.

Suborder LITUOLINA Lankester 1885
Superfamily LITUOLOIDEA de Blainville 1827
Family HAPLOPHRAGMOIDIDAE Maync 1952
Genus *Buzasina* Loeblich and Tappan 1985

Buzasina pacifica (Krasheninnikov 1973)
Plate 4, figure 11a, b

Labrospira pacifica KRASHENINNIKOV 1973, p. 209, pl. 2, figs. 4, 5.
Buzasina pacifica (Krasheninnikov). – KAMINSKI and GRADSTEIN 2005, p. 336, pl. 73, figs. 1–5. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 90, pl. 4, fig. 10. – WAŚKOWSKA 2015a, pl. 12, figs. t–v.

Remarks: Specimens have three visible chambers, and bear resemblance to *Buzasina galeata* (Brady).

Genus *Haplophragmoides* Cushman 1910

Haplophragmoides decussatus Krasheninnikov 1973
Plate 4, figure 12a, b.

Haplophragmoides decussatus KRASHENINNIKOV, 1973, p. 208, pl. 2, fig. 3a, b. –KRASHENINNIKOV, 1974, p. 635, pl. 1, fig. 6a-b. – BUBÍK, 1995, pl. 3, fig. 9a-b.

PLATE 1
All specimens are from Hole 1511B. Scale bars = 100 microns unless otherwise noted

1 *Nothia excelsa* (Grzybowski 1898), Sample 46R-2W, 75-77 cm

2 *Nothia latissima* (Grzybowski 1898), Sample 46R-3W, 120-122 cm

3 *Psammosiphonella cylindrica* (Glaessner 1937), Sample 46R-3W, 45-47 cm

4 *Psammosiphonella discreta* (Brady 1881), Sample 47R-3W, 52-54 cm

5 *Rhizammina algaeformis* Brady 1879, Sample 47R-3W, 52-54 cm

6-7 *Rhizammina* sp. 1, Sample 47R-3W, 52-54 cm. Sample 47R-3W, 52-54 cm

8 *Lagenammina* sp. 1, Sample 47R-3W, 10-12 cm

9 *Arthrodendron grandis* (Grzybowski 1898). Sample 47R-3W, 52-54 cm

10 *Placentammina placenta* (Grzybowski 1898), Sample 47R-3W, 52-54 cm

11-12 *Saccammina grzybowskii* (Schubert 1902), Sample 46R-3W, 120-122 cm

13 *Psammosphaera* sp. 1. Sample 46R-3W, 120-122 cm

14 *Jaculella* sp., Sample 45R-2W, 0-2 cm

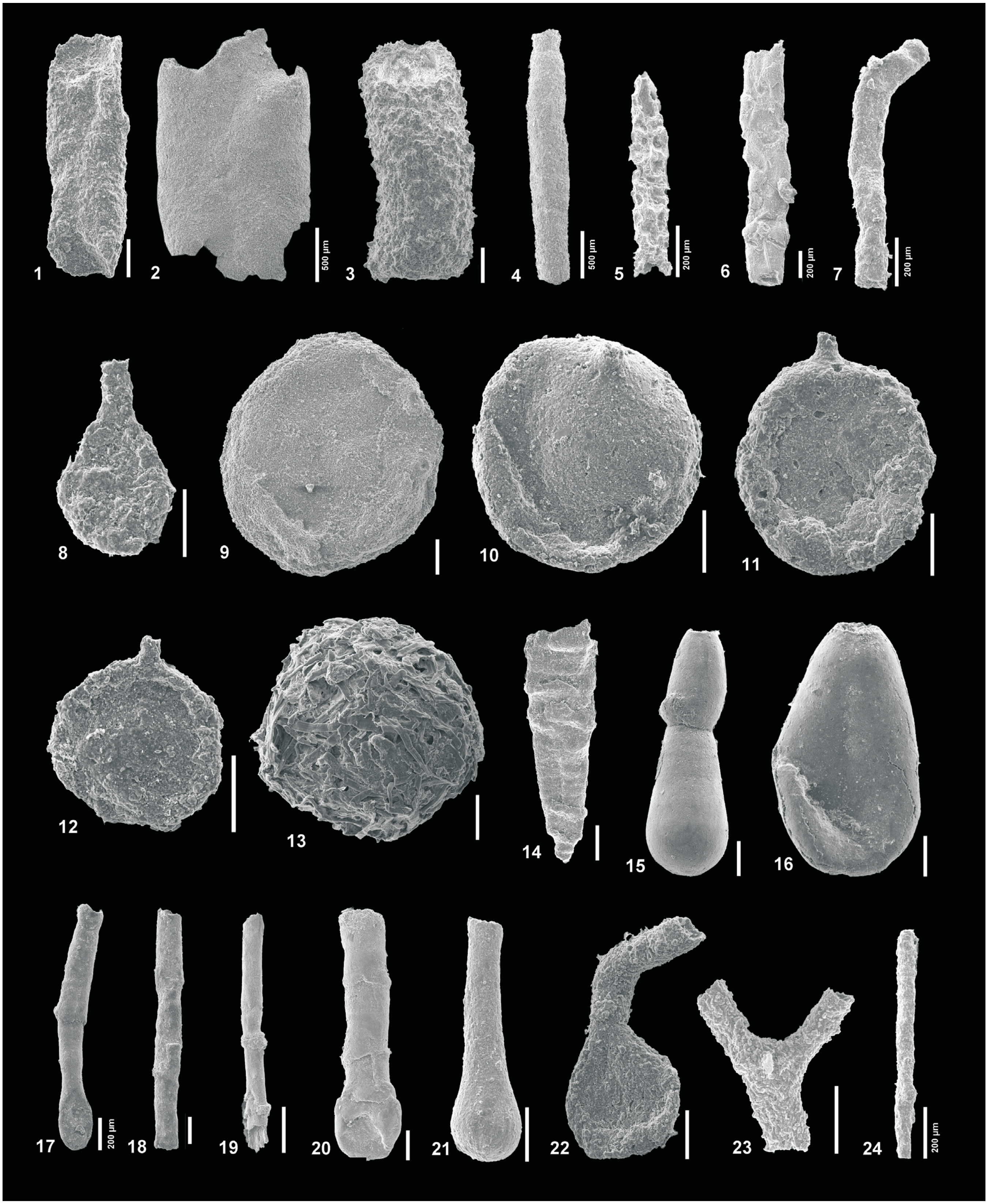
15-16 *Hyperammina dilatata* Grzybowski 1896, Sample 47R-3W, 52-54 cm

17-19 *Hyperammina kenmilleri* Kaminski 1989, Sample 46R-1W, 141-142 cm

20-21 *Hyperammina erugata* Sliter 1968, Sample 47R-1W, 30-32 cm

22 *Hyperammina* sp. 1, Sample 46R-2W, 50-52 cm

23-24 *Rhizammina* sp. 2, Sample 47R-3W, 52-54 cm. Sample 47R-3W, 52-54 cm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Remarks: Chambers increase rapidly in size, as in Krasheninnikov's (1974) specimens from the Indian Ocean.

Haplophragmoides porrectus Maslakova 1955
Plate 4, figures 13a-14b

Haplophragmoides porrectus MASLAKOVA 1955, p. 47, pl. 3, figs. 5–6. – KAMINSKI, GRADSTEIN, BERGGREN, GEROCH and BECKMANN 1988, p. 189, pl. 5, figs. 7, 8. – KAMINSKI and GRADSTEIN 2005, p. 353, pl. 79, figs. 1a–6. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 275, pl. 8, fig. 1a, b. – SETOYAMA and KAMINSKI 2015, p. 246, pl. 3, fig. 1

Remarks: This species is distinguished from the other species by its elliptical outline, inflated chambers and incised, radial sutures.

Haplophragmoides suborbicularis (Grzybowski 1896)
Plate 4, figure 15a, b

Cyclammina suborbicularis GRZYBOWSKI 1896, p. 284, pl. 9, figs. 5, 6
Haplophragmoides suborbicularis (Grzybowski). – WEBB 1975, p. 834, pl. 2, figs. 8, 9. – KAMINSKI and GRADSTEIN 2005, p. 358, pl. 81, figs. 1–3.

Remarks: A robust form with a thick wall.

Haplophragmoides* cf. *walteri (Grzybowski 1898)
Plate 4, figure 16a, b

cf. *Trochammina walteri* GRZYBOWSKI 1898, p. 290, pl. 11, fig. 31.
Haplophragmoides cf. *walteri* (Grzybowski). – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 90, pl. 4, figs. 13-14. – SETOYAMA and KAMINSKI 2015, p. 246, pl. 2, fig. 16.

Description. Test of medium size, planispiral, slightly evolute, flattened with acute periphery. Chambers triangular, increasing in size slowly as added, about nine in the final whorl. Sutures slightly depressed, straight or curved backwards. Wall finely agglutinated, fine to slightly rough. Aperture an interiomarginal slit.

Remarks: This form differs from *Haplophragmoides walteri* by being slightly evolute and lacking the keel-like periphery, and also from *Haplophragmoides* cf. *walteri* previously described from the other western Tethyan localities, for example, by Moullade et al. (1988), Kuhnt (1990), and Kaminski et al. (2011) by possessing more chambers in the final whorl. Some specimens show an apertural-lip-like structure.

Subfamily PRAESPHAERAMMININAE Kaminski and Mikhalevich 2004
Genus *Praesphaerammina* Kaminski and Filipescu 2000

Praesphaerammina gerochi (Hanzlíková 1972)
Plate 4, figure 17

Sphaerammina gerochi HANZLÍKOVÁ 1972, p. 45, pl. 8, figs. 4–7.
Praesphaerammina gerochi (Hanzlíková). – KAMINSKI and GRADSTEIN 2005, p. 367, pl. 84, figs. 1a–4b. – KAMINSKI, CETEAN, BĂLC and COCCIONI 2011, p. 91, pl. 4, fig. 15. – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 91, pl. 31, figs. A–C.

Remarks: A thin-walled form always found compressed.

PLATE 2
Scale bars = 100 microns unless otherwise noted.

1-2 *Ammolagena clavata* (Jones and Parker 1860), Sample 47R-3W, 52-54 cm

3 *Caudammina ovula* (Grzybowski 1896) emend. Geroch 1960, Sample 47R-3W, 52-54 cm

4-5 *Caudammina ovuloides* (Grzybowski 1901), Sample 46R-2W, 50-52 cm

6 *Subreophax aduncus* (Brady 1882), Sample 47R-3W, 52-54 cm

7 *Subreophax longicameratus* Kaminski, Cetean, Bălc nd Coccioni 2011, Sample 47R-3W, 52-54 cm

8 *Subreophax scalaris* (Grzybowski 1896), Sample 47R-3W, 52-54 cm

9-10 *Subreophax pseudoscalaris* (Samuel 1977), Sample 47R-1W, 30-32 cm

11 *Agathamminoides serpens* (Grzybowski 1898), Sample 47R-1W, 30-32 cm

12a,b *Ammodiscoides* sp. 1, Sample 47R-3W, 52-54 cm

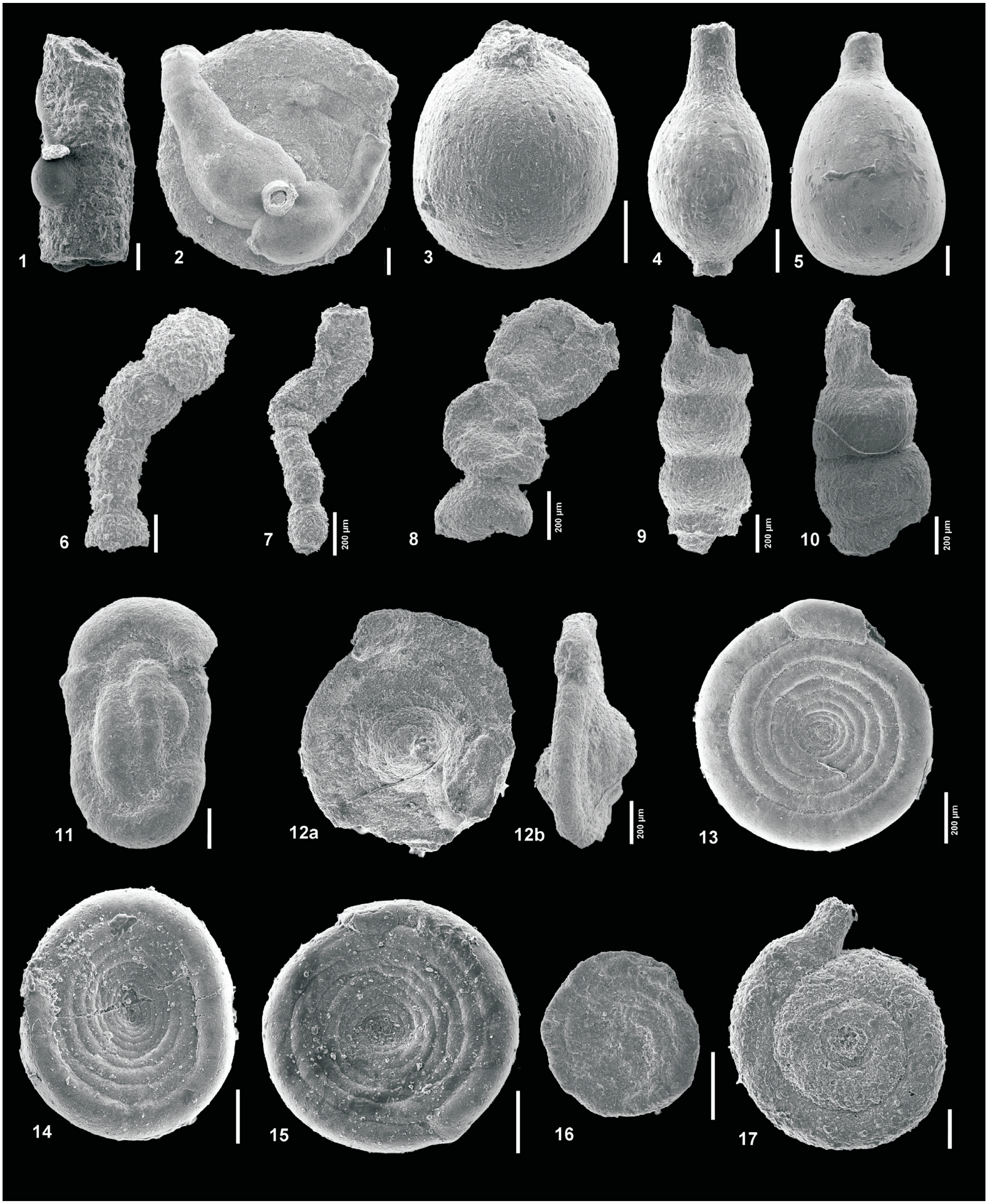
13 *Ammodiscus cretaceus* (Reuss 1845), Sample 47R-3W, 52-54 cm

14 *Ammodiscus glabratus* Cushman and Jarvis 1928, Sample 47R-3W, 52-54 cm

15 *Ammodiscus tenuissimus* Grzybowski 1898, Sample 47R-1W, 101-103 cm

16 *Ammodiscus* cf. *planus* Loeblich 1946, Sample 46R-2W, 122-124 cm

17 *Dolgenia pennyi* (Cushman and Jarvis 1928), Sample 47R-2W, 109-111 cm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Superfamily RECURVOIDOIDEA Alekseychik-Mitskevich 1973
Family AMMOSPHAEROIDINIDAE Cushman 1927
Subfamily AMMOSPHAEROIDININAE Cushman 1927
Genus *Ammosphaeroidina* Cushman 1910

Ammosphaeroidina pseudopauciloculata (Mjatliuk 1966)
Plate 5, figure 1

Cystamminella pseudopauciloculata MJATLIUK 1966, p. 246, pl. 1, figs. 5–7; pl. 2, fig. 6; pl. 3, fig. 3.
Ammosphaeroidina pseudopauciloculata (Mjatliuk). – KAMINSKI, GRADSTEIN BERGGREN, GEROCH and BECKMANN 1988, p. 193, pl. 8, figs. 3a–5. – KAMINSKI and GRADSTEIN 2005, p. 376, pl. 87a, figs. 1a–5; pl. 87b, figs. 1a–10 (with synonymy). – WAŚKOWSKA-OLIWA 2008, p. 247, pl. 8, figs. 5–6. – KENDER, KAMINSKI and JONES 2008a, p. 126, pl. 9, fig. 3. – KENDER, KAMINSKI and JONES 2008b, p. 501, pl. 6, fig. 7. – SETOYAMA, KAMINSKI and TYSZKA 2011, pl. 268, pl. 11, figs. 2, 3. – SETOYAMA and KAMINSKI 2015, p. 246, pl. 3, fig. 4.

Genus *Cystammina* Neumayr 1889

Cystammina sveni Gradstein and Kaminski 1997
Plate 5, figure 2

Cystammina sveni GRADSTEIN and KAMINSKI 1997, p. 225, figs. 11, 12 (1–6). – HOLBOURN, HENDERSON and MACLEOD 2013, p. 228, figs. 1–3. – WAŚKOWSKA-OLIWA 2008, pl. 148, pl. 7–8. – WAŚKOWSKA2011, fig. 6 (12-18). – SETOYAMA and KAMINSKI 2015, p. 247, pl. 3, figs. 5, 6.

Remarks: The extent of the areal, slit-like aperture differs among the specimens. Specimens without a clear lip are also included. The species has also been reported from the Carpathian turbidites (Waśkowska 2011).

Subfamily RECURVOIDINAE Alekseychik-Mitskevich 1973
Genus *Cribrostomoides* Cushman 1910

Cribrostomoides subglobosus (Cushman 1910)
Plate 5, figure 3a, b

Lituola subglobosa M. Sars 1869 (nomen nudum)
Haplophragmoides subglobosum (Sars). – CUSHMAN 1910, p. 105, figs. 162–164.
Cribrostomoides subglobosus (Cushman). – KENDER, KAMINSKI and JONES 2008a, p. 126, pl. 9, fig. 8. – KENDER, KAMINSKI and JONES 2008b, p. 502, pl. 6, fig. 9. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 220, figs. 1, 2. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 188, pl. 2, fig. 7.
Cribrostomoides subglobosus (Cushman) forma *subglobosus*. – JONES et al. 1993, pl. 1, figs. 1–5; pl. 2, figs. 6–8; pl. 3, figs. 1–7. – KAMINSKI and GRADSTEIN 2005, p. 391, pl. 92, figs. 1–3.

Remarks: Differs from ?*Cribrostomoides trinitatensis* Cushman and Jarvis by its larger dimensions, narrower test and a single interio-areal to areal aperture.

Genus *Recurvoidella* Uchio 1960

Recurvoidella lamella (Grzybowski 1898)
Plate 5, figure 4a,b

Trochammina lamella Grzybowski 1898, p. 290, pl. 11, fig. 25.
Recurvoidella lamella (Grzybowski 1898). – KAMINSKI and GRADSTEIN, 2005, p. 400, pl. 94, figs. 1-9.

PLATE 3
Scale bars = 100 microns unless otherwise noted.

1a,b *Arenoturrispirillina micra* Subbotina 1958, Sample 47R-3W, 94-95 cm

2 *Glomospirella* sp. 1, Sample 47R-3W, 52-54 cm

3 *“Glomospira” irregularis* (Grzybowski 1898), Sample 47R-3W, 52-54 cm

4-5 *Glomospira* sp. 4, Sample 46R-3W, 120-122 cm

6 *Repmanina charoides* (Jones and Parker 1860), Sample 47R-2W, 109-111 cm

7 *Lituotuba lituiformis* (Brady 1879), Sample 46R-3W, 120-122 cm

8-9 *Paratrochamminoides acervulatus* (Grzybowski 1896), Sample 47R-2W, 109-111 cm

10-11b *Paratrochamminoides deflexiformis* (Noth 1912), Sample 46R-3W, 80-82 cm

12 *Paratrochamminoides gorayskii* (Grzybowski 1898), Sample 46R-3W, 120-122 cm

13 *Paratrochamminoides mitratus* (Grzybowski 1901), Sample 47R-1W, 30-32 cm

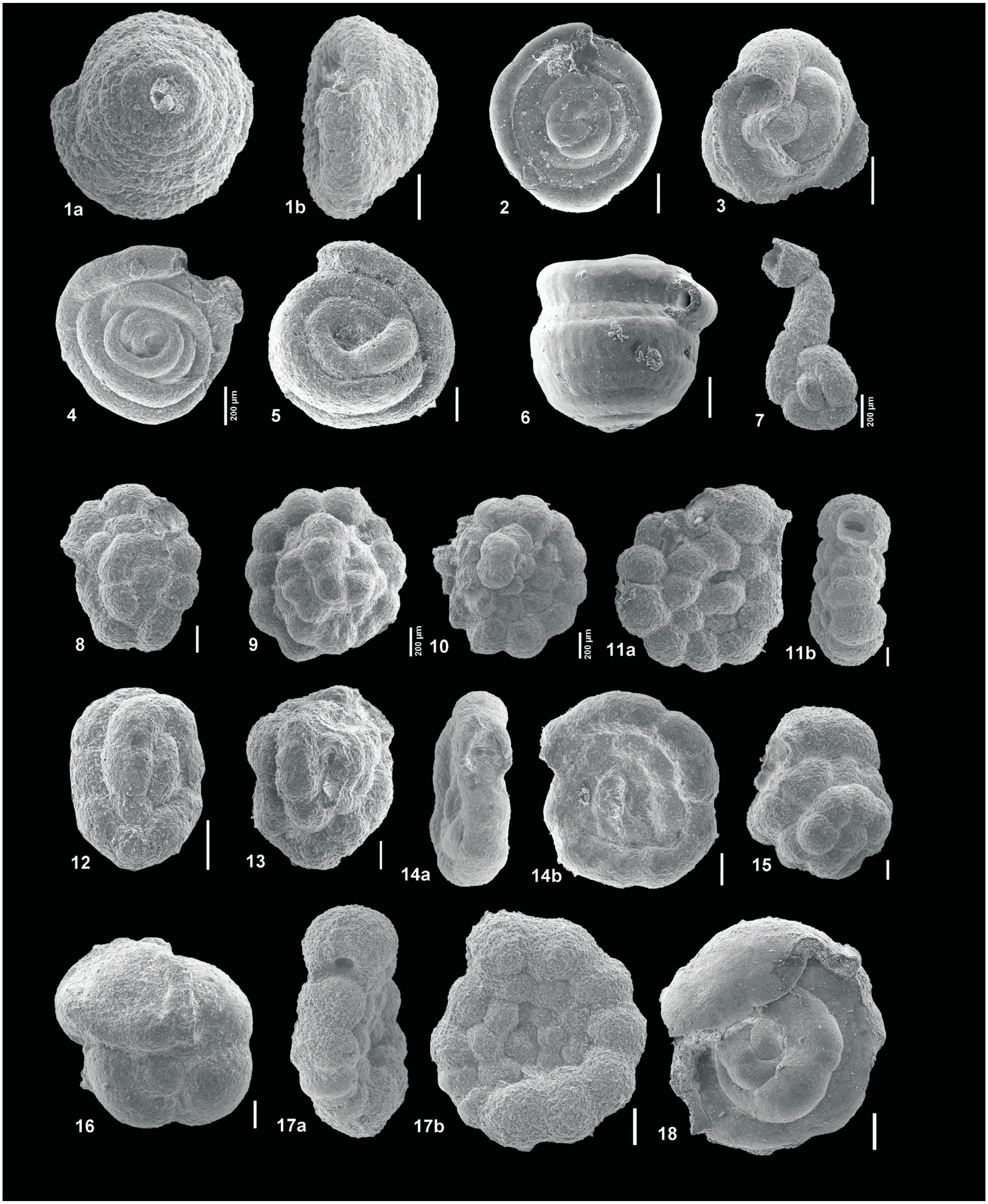
14a,b *Paratrochamminoides olszewskii* (Grzybowski 1898), Sample 47R-2W, 109-111 cm

15 *Paratrochamminoides uviformis* (Grzybowski 1898), Sample 46R-3W, 80-82 cm

16 *Conglophragmium irregularis* (White 1928), Sample 46R-2W, 122-124 cm

17a,b *Trochamminoides grzybowskii* Kaminski and Geroch 1992, Sample 46R-1W, 141-142 cm

18 *Trochamminoides dubius* (Grzybowski), Sample 46R-2W, 25-27 cm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Recurvoidella? lamella (Grzybowski 1898). – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 98, pl. 34, fig. A.

Description. Test of medium size, circular in outline, planispirally coiled with the coiling axis slightly variable, with about six chambers in the final whorl. Periphery broadly rounded. Sutures slightly depressed, thick. Wall finely agglutinated with much cement. Aperture a basal slit. An apertural lip is not observed.

Genus *Recurvoides* Earland 1934

Recurvoides anormis Mjatliuk 1970
Plate 5, figures 6a, b

Recurvoides anormis MJATLIUK 1970, p. 84, pl. 18, fig. 4; pl. 19, figs. 1–4. – KAMINSKI and GRADSTEIN 2005, p. 402, pl. 95, figs. 1–7.

Remarks: Recognized by its aperture, which is oval, surrounded by a lip, and in the middle of the apertural face.

***Recurvoides* sp.**
Plate 5, figures 5a, b; 7a, b

Remarks: Most closely resembles the Paleogene species *Recurvoides dissonus* Mjatliuk because of its tight coiling.

Family AMMOBACULINIDAE Saidova 1981
Subfamily AMMOBACULININAE Saidova 1981
Genus *Bulbobaculites* Maync 1952

***Bulbobaculites* sp. 1**
Plate 5, figure 8

Remarks: A rare species, with a tightly coiled streptospiral part and a uniserial part consisting of about 4 inflated chambers.

Suborder SPIROPLECTAMMININA Mikhalevich 1992
Superfamily SPIROPLECTAMMINOIDEA Cushman 1927
Family SPIROPLECTAMMINIDAE Cushman 1927
Subfamily SPIROPLECTAMMININAE Cushman 1927
Genus *Spiroplectammina* Cushman 1927

Spiroplectammina spectabilis (Grzybowski 1898) emend. Kaminski 1984
Plate 5, figures 9-10

Spiroplecta spectablis GRZYBOWSKI 1898, p. 293, pl. 12, fig. 12.
Bolivinopsis spectabilis (Grzybowski). – WEBB 1975, p. 835, pl. 3, figs. 1-3.
Spiroplectammina spectabilis (Grzybowski). – KAMINSKI 1984, p. 31, pl. 12, figs. 1–9; pl. 13, figs. 1–8. – KAMINSKI and GRADSTEIN 2005, p. 435, pl. 104, figs. 1a–6b (with synonymy). – WAŚKOWSKA-OLIWA 2008, p. 252, pl. 9, figs. 1–3. – SETOYAMA, KAMINSKI and TYSZKA 2011, p. 285, pl. 11, figs. 8, 9. – HOLBOURN, HENDERSON and MACLEOD 2013, p. 533, figs.

PLATE 4
Scale bars = 100 microns unless otherwise noted.

1 *Rzehakina fissistomata* (Grzybowski 1901), Sample 47R-2W, 109-111 cm

2 *Rzehakina epigona* (Rzehak 1895), Sample 47R-3W, 10-12 cm

3 *Rzehakina lata* Cushman and Jarvis 1928, Sample 45R-1W, 92-94 cm

3 *Rzehakina minima* Cushman and Renz 1946, Sample 47R-3W, 52-54 cm

4-5 *Spirosigmoilinella* sp. Sample 47R-2W, 25-27 cm

6 *Kalamopsis grzybowskii* (Dylążanka 1923), Sample 46R-2W, 50-52 cm

7 *Reophax* sp. 1, Sample 47R-3W, 52-54 cm

8-9 *Hormosina velascoensis* (Cushman 1926), Sample 47R-3W, 52-54 cm

10 *Pseudonodosinella elongata* (Grzybowski 1898), Sample 46R-2W, 122-124 cm

11a,b *Buzasina pacifica* (Krasheninnikov 1973), Sample 46R-2W, 122-124 cm

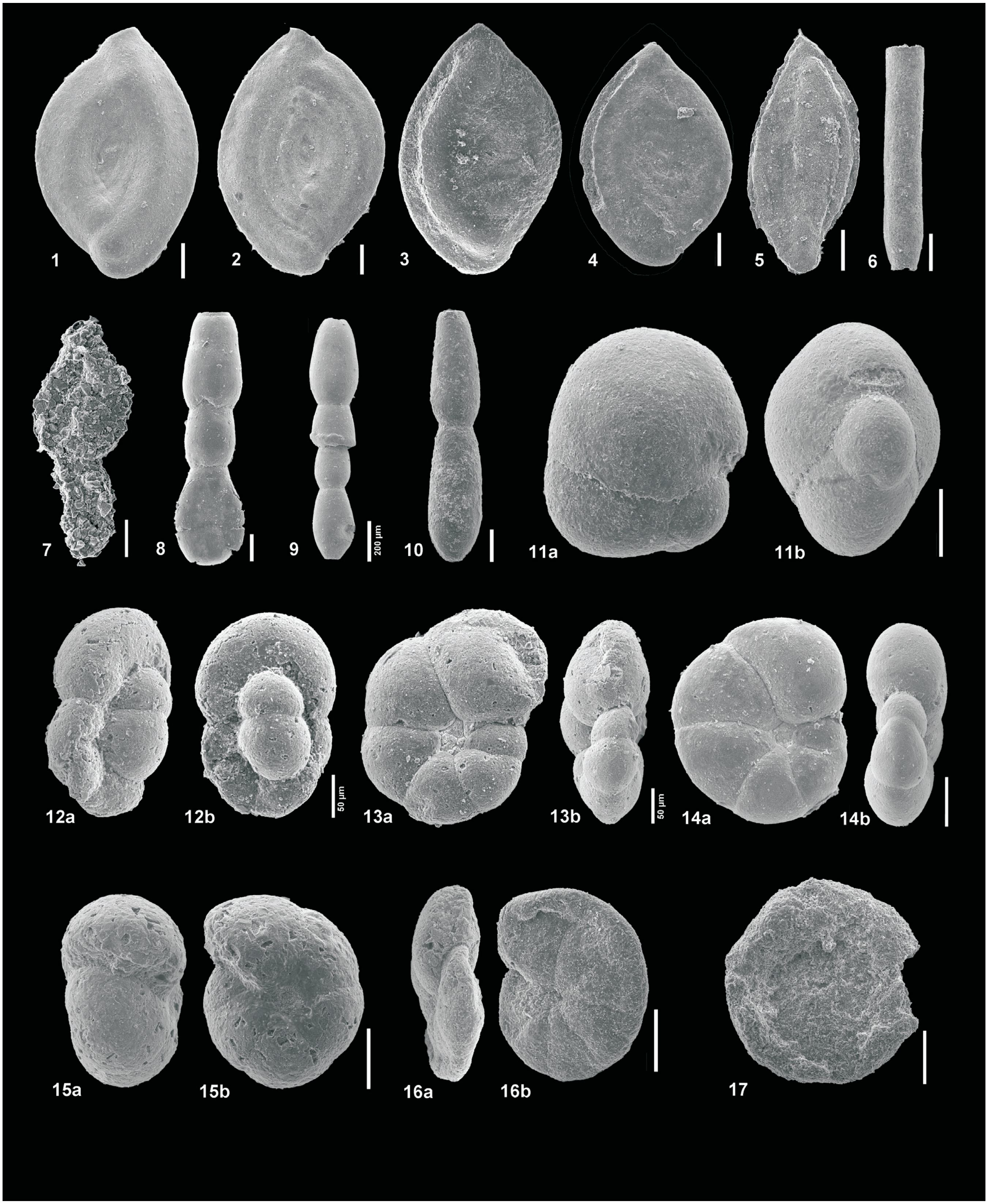
12a,b *Haplophragmoides decussatus* Krasheninnikov 1973, Sample 47R-3W, 52-54 cm

13a-14b *Haplophragmoides porrectus* Maslakova 1955, Sample 47R-2W, 109-111 cm

15a,b *Haplophragmoides suborbicularis* (Grzybowski 1896), Sample 46R-2W, 50-52 cm

16a,b *Haplophragmoides* cf. *walteri* (Grzybowski 1898), Sample 46R-3W, 80-82 cm

17 *Praesphaerammina gerochi* (Hanzlíková 1972), Sample 46R-2W, 122-124 cm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1–3. – WAŚKOWSKA and CIESZKOWSKI 2014, pl. 8, figs. g–i. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 196, pl. 2, fig. 11.

Remarks: Both megalospheric and microspheric forms were found. The species in common in most samples.

Suborder TROCHAMMININA Saidova 1981
Superfamily TROCHAMMINOIDEA Schwager 1877
Family TROCHAMMINIDAE Schwager 1877
Subfamily TROCHAMMININAE Schwager 1877
Genus *Trochammina* Parker and Jones 1859

***Trochammina* sp.**
Plate 5, figure 12a, b

Remarks: Small, flattened specimens of the genus are included.

Suborder VERNEUILININA Mikhalevich and Kaminski 2004
Superfamily VERNEUILINOIDEA Cushman 1911
Family CONOTROCHAMMINIDAE Saidova 1981
Genus *Conotrochammina* Finlay 1940

Conotrochammina whangaia Finlay 1940
Plate 5, figure 13

Conotrochammina whangaia FINLAY 1940, p. 448, pl. 62, figs. 1, 2. – WEBB 1975, p. 835, pl. 3, fig. 10. – KAMINSKI and GRADSTEIN 2005, p. 463, pl. 1–7. – SETOYAMA, KAMINSKI and TYSZKA 2017, p. 188, pl. 4, fig. 5.

Remarks: This species can be distinguished from other trochamminids by its high trochospire, coarsely agglutinated wall and areal aperture.

Family PROLIXOPLECTIDAE Loeblich and Tappan 1985
Genus *Karrerulina* Finlay 1940

Karrerulina conversa (Grzybowski 1901)
Plate 5, figure 11

Gaudryina conversa GRZYBOWSKI 1901, p. 285, pl. 7, figs. 15, 16.
Karreriella conversa (Grzybowski). – WEBB 1975, p. 835, pl. 3, fig. 12.
Karrerulina conversa (Grzybowski). – KAMINSKI and GRADSTEIN 2005, p. 468, pl. 116, figs. 1a–11b (with synonymy). – WAŚKOWSKA, HNYLKO, KAMINSKI and BAKAYEVA 2020, p. 122, pl. 48, fig. A; pl. 49, figs. A–C.

Remarks: As pointed out by Waśkowska et al. (2020), the species *K. conversa* may be a junior synonym of the species *Virgulina digitalis* Grzybowski 1896. Because the name *K. conversa* is widely used in the literature, they regarded the name to be *nomen protectum*.

Suborder LOFTUSIINA Kaminski and Mikhalevich 2004
Superfamily LOFTUSIOIDEA Brady 1884
Family CYCLAMMINIDAE Marie 1941
Subfamily ALVEOLOPHRAGMIINAE Saidova 1981
Genus *Reticulophragmium* Maync 1955

Reticulophragmium pauperum (Chapman 1904) emend. Ludbrook 1977
Plate 5, figures 14a-15b

Cyclammina paupera CHAPMAN 1904, p. 229, pl. 22, fig. 6.
Reticulophragmium pauperum (Chapman 1904) emend. Ludbrook 1977. – KAMINSKI and GRADSTEIN 2005, p. 501, pl. 126, figs. 1–7.

PLATE 5

Scale bars = 100 microns unless otherwise noted.

1 *Ammosphaeroidina pseudopauciloculata* (Mjatliuk 1966), Sample 46R-2W, 50-52 cm

2 *Cystammina sveni* Gradstein and Kaminski 1997, Sample 46R-2W, 122-124 cm

3a,b *Cribrostomoides subglobosus* (Cushman 1910), Sample *46R-3W, 8-10 cm*

4a,b *Recurvoidella lamella* (Grzybowski 1898), Sample 46R-3W, 120-122 cm

5a,b *Recurvoides* sp., Sample 46R-3W, 120-122 cm

6a,b *Recurvoides anormis* Mjatliuk 1970, Sample 46R-3W, 8-10 cm

7a,b *Recurvoides* sp., Sample 46R-2W, 50-52 cm

8 *Bulbobaculites* sp. Sample 46R-2W, 100-102 cm

9 *Spiroplectammina spectabilis* (Grzybowski 1898), microspheric generation, Sample 47R-2W, 109-111 cm

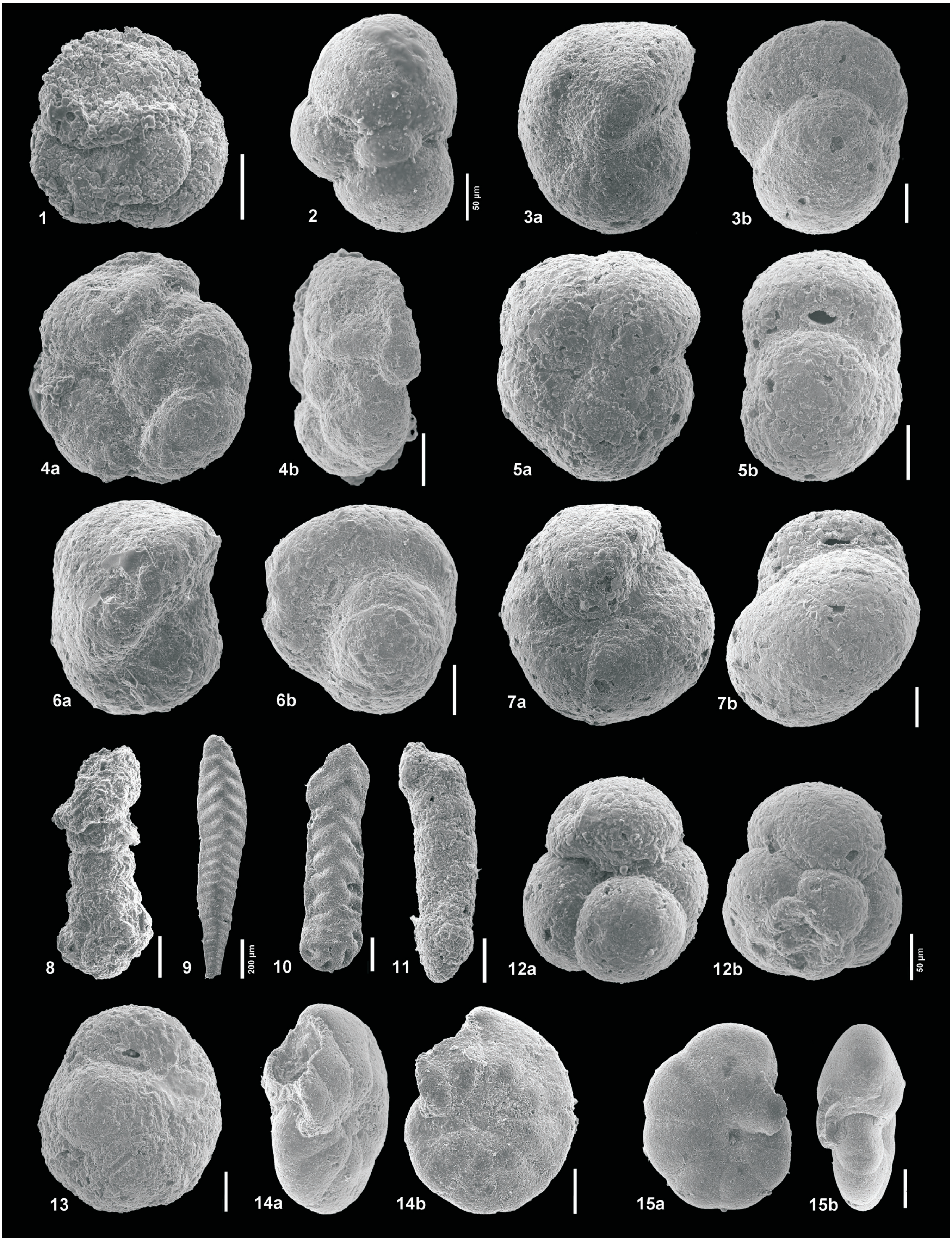
10 *Spiroplectammina spectabilis* (Grzybowski 1898), megalospheric generation, Sample 47R-1W, 30-32 cm

11 *Karrerulina conversa* (Grzybowski 1901), Sample 47R-1W, 30-32 cm

12a,b *Trochammina* sp. Sample 46R-2W, 50-52 cm

13 *Conotrochammina whangaia* Finlay 1940, Sample 47R-2W, 109-111 cm

14a-15b *Reticulophragmium pauperum* (Chapman 1904), Sample 47R-1W, 101-103 cm


1
2
50 µm
3a
3b
4a
4b
5a
5b
6a
6b
7a
7b
8
9
200 µm
10
11
12a
12b
50 µm
13
14a
14b
15a
15b

Remarks: Our specimens are of medium size, have a lenticular test shape, with 8–9 chambers in the final whorl, straight radial sutures, subacute periphery, umbilical shoulders, and a depressed umbo. In smaller specimens, the alveoles are concentrated near the sutures. The specimens are similar to specimens from the North Sea (see Kaminski and Gradstein, 2005), but have fewer chambers.

DISCUSSION

The foraminiferal assemblage from the base of the cored interval in Hole U1511B is strongly dominated by agglutinated foraminifera, which confirms the findings of Webb (1975) at DSDP Site 283 on the conjugate margin of the Tasman Sea. The assemblage contains primitive *Reticulophragmium*, which is characteristic of the middle to late Paleocene in the Caribbean and northern Atlantic petroleum basins (Gradstein et al. 1994; Kaminski and Crespo de Cabrera 1999). Furthermore, the assemblage also contains common *Spiroplectammina spectabilis*, a species that forms acmes in the Paleocene in the northern Atlantic (North Sea and western Barents Sea: e.g., Nagy et al. 1997). The taxonomic composition of the assemblage shows strong similarities to the foraminiferal content of the Paleocene Lizard Springs Formation of Trinidad (Kaminski et al. 1988) and the Paleocene assemblages of the Carpathian flysch deposits (Geroch 1960; Jurkiewicz 1967). The recovered assemblage consists entirely of "cosmopolitan" forms originally described from the Carpathians and western Tethys. The lack of any endemic species in the recovered material proves that the "western Tethyan DWAF faunas" first described by Grzybowski are truly cosmopolitan. This observation is supported by the occurrence of cosmopolitan calcareous species such as *Stensioeina beccariiformis*, *Nuttallides truempyi,* and *Oridorsalis umbonatus* (Van Morkhoven et al. 1986; Alegret et al. 2021). We suggest that any endemic species may have been restricted to shallower settings across the Zealandia continental margin.

One striking feature of the DWAF assemblage at Site U1511 is the excellent preservation state of the specimens. This fact was already pointed out by Webb (1975) in his studies of samples from Hole 283. The specimens are not strongly silicified, which is typically seen in the Carpathian material, and they are preserved in three-dimensions rather than being flattened. Even thin-walled species such as *Placentammina placenta* and *Buzasina pacifica* are still partially or fully inflated. The excellent preservation state is ascribed to the shallow burial (ca. 450 m of overburden) and small amount of post-depositional compaction. Such preservation will enable detailed studies of the wall structure of the DWAF species at this site.

CONCLUSIONS

A Paleocene DWAF assemblage consisting of more than 70 species was recovered from the deepest sediment drilled at Site U1511. The assemblage consists entirely of cosmopolitan forms – no endemic species were encountered at this locality. The presence of well-developed specimens of *Reticulophragmium pauperum* provides an independent age determination of mid-late Paleocene for the oldest sediments recovered in Hole 1511B. The recovered specimens display excellent three-dimensional preservation, hence the core represents a lagerstätte deposit for DWAF.

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